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Admiral Sir EDWARD BELCHER said, with regard to drift, within this year two sea substances which existed about Teneriffe had been blown ashore at Torquay, and within the last week a Portuguese man-of-war, or *Physalia*, had been cast ashore at the same place.

3. *On Open Water in the Polar Basin.* By Captain R. V. HAMILTON, R.N.

THE idea of an open sea and milder climate in the vicinity of the Pole has, at all events, the merit of antiquity to recommend it, and has been adopted on scientific grounds by many of our modern eminent geographers—amongst them Maury, who endeavours to support the conclusions arrived at theoretically, by arguments drawn from modern Arctic explorers, and the celebrated drifts of the *Advance*, *Resolute*, and *Fox*. It would, indeed, be presumptuous on my part to dispute the justness of the scientific deductions of so eminent a philosopher; but, having the practical experience of two Arctic voyages, I trust to show the deductions he has drawn from the accounts of voyages are erroneous, and would not have been drawn had his personal experience of ice-movements been equal to his scientific knowledge.

Maury's arguments [*] may be briefly expressed as follows:—

1. He infers [†] that a warm under current sets through Baffin's Bay into the Polar basin, and eventually rises to the surface and ameliorates the climate.

2. On the indications of a milder climate as shown by the migration of birds.[‡]

3. On the open sea seen by Penny and Kane in Wellington and Kennedy channels,[§] and an erroneous idea that Kane procured subsistence for his party on the borders of this "ice-bound sea."

4. On the assumption that the drifts of the *Fox* and *Advance* were caused by "a tongue of ice 1000′ long, coming out of the Polar sea *formed at the edge of open water in it*." [||]

It would extend beyond the limits of a paper to give full quotations from Maury: I will, therefore, endeavour to convey his meaning; and as it is principally with the last argument I intend to deal I shall reply very briefly to the three first.

He infers,[¶] from the very exceptional case of icebergs having been seen drifting north, that an under current exists which must come from the tropics, and is therefore warm.

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[*] Eighth edition, 1861.
[†] Pars. 424-484.
[‡] *Ib.* 425.
[§] *Ib.* 428-432.
[||] *Ib.* 431, 476-8.
[¶] *Ib.* 424.

To this I reply that, beyond doubt, an enormous majority of bergs drift south; none have been seen to the westward of Barrow's Straits or Jones's Sound, or to the northward of the Parry Island, nor in the open sea of Kane, notwithstanding this supposed submarine current and its close proximity to the great nursery of bergs (if I may use the expression) in the head of Baffin's Bay. According to the drift of bergs, this current should be the other way; but as few are over 100 fathoms below the surface, and Baffin's Bay is probably much deeper, no argument for or against can, in my opinion, be drawn from their drift, and M'Clintock in December, 1857,* says, "Neither surface nor submarine currents were detected."

This warm under current may come to the surface and ameliorate the climate; but I am not aware of any cold Polar current coming to the surface and tempering the heat of tropical climates, and that cold under currents exist in the tropics is beyond dispute.

Regarding his second argument, Maury states, "The observations of explorers indicate the existence of a milder climate, which may also be inferred from the migration of birds to the northward, evidently in search of a milder climate, which can only be caused by the proximity of a large body of open water." †

In reply to this, I am not aware who the explorers are who have given practical proofs of this milder climate.

The following facts will show climate is not the cause of the birds migrating.

Ptarmigan were killed in numbers by the *Plover's* crew during their four winters in Behring's Straits. Some also at Port Kennedy by the *Fox's* crew in February, 1857, temp. 47°. Two were on Dealy Island all the winter of 1852, and shot in February.

M'Clintock and De Haven, during their drifts down Baffin's Bay, saw dovekies throughout the winter. Richardson mentions water-fowl, such as dovekies, wintering off Spitzbergen.

Water-fowl are always shot long before the disruption of the ice, in the cracks and lanes of water; and as most of them migrate from our latitudes to the Polar regions, it can scarcely be said they are seeking a milder climate; but, like the salmon that always returns to its native river, these birds' instinct probably lead them to return to their native haunts and open water, where they can breed undisturbed.

Regarding the open seas of Penny and Kane, and the subsistence procured by the latter for his crew in his Polynia, Penny's may be briefly dismissed, as we now know it was only a considerable space of water with an icy barrier north and south of it, which was also apparently the case in 1853-4, and is therefore probably owing to local causes, such as strong tides or currents in the vicinity of Baillie Hamilton Island, certainly not to a warmer current rising to the surface or the thermometer would have indicated it.

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* Voyage of the *Fox*, chap. v.

† Par. 425.

Kane's, or more properly Morton's open sea, in Kennedy Channel, is of more considerable extent; but from his elevation, 480 feet, the visible horizon is only 25 miles off, and it was seen at the end of June and beginning of July. What was its state in winter? Certainly frozen, for Hayes in May, 1861, found ice there, but much decayed.* It must also be remembered that Morton, although doubtless an intelligent man, was only the officer's servant, and therefore his account must be received with caution.

" Seals were sporting and water-fowl were feeding in it." † With regard to the animal life seen in this sea as a proof of an open sea, the same might have been seen in any part of the known Arctic sea where there was open water. M'Clintock and De Haven both saw seals, dovekies, and narwhals in the lanes of water throughout the winter. At Port Kennedy a few seals were seen in February. At the Bay of Mercy a seal was killed in midwinter in the firehole of the *Investigator*. And in April, 1854, at Beechy Island, a bear was seen digging down into a deep snow-drift, and eventually brought up a seal, probably from its cave in the snow, where it had brought forth its young. These instances will, I think, prove that an open sea is not required for animal life, and conversely the presence of animal life is no proof of a warmer open sea. I should rather say the contrary, as the unusual warmth of this ocean-climate would probably be as unpleasant to Arctic seals and walrusses, as the tropics would be to Esquimaux suddenly transported there. So far from Kane procuring subsistence for his party, as Maury asserts,‡ on " the shore of this ice-bound sea," but for the Etah Esquimaux they would have starved,§ although he had Hans, an Esquimaux, and Petersen, a Greenland Dane, in his party, both skilled and enthusiastic hunters.

In March the Etah Esquimaux had been compelled by hunger to eat 26 out of 30 of their dogs, and in 1858 M'Clintock heard that Hans, who had remained behind amongst them, had been compelled to eat the sealskin which covered the framework of his kayak (the very last resource of an Esquimaux).

It is a curious fact that the coldest mean temperatures for the summer months and for the year are those of Dr. Kane and Sir Edward Belcher,—the three nearest winter-quarters to the supposed Polynia,—and that they procured scarcely any game. While Melville Island and Banks' Land abound in game, and the Polynia has never been placed near them.

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* American Philosophical Society's Transactions, Dec. 1861.

† Maury, par. 429. ‡ *Ib.* 432. § Kane's Voyage.

We now come to Maury's last argument.* To support which, he asserts that the drift of the *Fox*, *Advance*, and *Resolute*, is sufficient of itself " to establish the existence of an open sea in the Arctic Ocean." He says, † every year a tongue of ice 1000′ long is projected out of it through Kennedy and Wellington channels down Baffin's Bay, and which he supposes to drift from the southern edge of the open sea " as fast as it is formed during the winter ; " and it is " the compact and cold middle ice " of Baffin's Bay, which he asserts is much heavier when first encountered to the southward than when crossing to the west coast through it in the north water. " In this fact," he says, " we recognise another argument favouring the existence of an open sea." As the southern ice was formed early in the winter, consequently had longer time to grow thick, " while that which was formed at the edge of the open water in April or March would drift out, and not attain much thickness before it began to thaw," and consequently " experience has taught the whaler to look north for the first breaking up and the earliest passage through the middle ice." If this latter argument is correct the voyage to the Pole would indeed be an easy matter, for once having rounded the northern part of the middle ice, which is never done till June, when the formation of ice is over for the season, there would be no more to encounter. But Hayes and Kane, neither of whom were much impeded by the " middle ice," tell a different tale, and describe fierce tournaments with the icy guardian of the portal to the Polar basin, in which they were worsted, although their energy and perseverance to pass through Kennedy Channel deserved the success it did not command.

A glance at the chart will show how improbable it is that such a drift as Maury imagines should occur through the narrow and winding Wellington and Kennedy channels.

I unhesitatingly assert these drifts had nothing to do with any movements of the ice in the Polar basin, as, I trust, the remarks I am now about to offer on the formation of floes and a brief analysis of the drifts will show.

De Haven in his official report,‡ speaking of being frozen in at the entrance of Wellington Channel, says:—" Sept. 13th. There was nothing to obstruct our progress but the bay ice (*i. e.*, young ice formed by the sea freezing), which with a good breeze blowing would not have impeded us much, but the wind failed. The snow, with which the surface of the water was covered, rapidly cemented and formed a tenacious coat, through which it was impossible to force the vessels. At 8 P.M. they came to a dead stand 10 miles east of Barlow Inlet.

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* Par. 475. † Par. 459. ‡ De Haven's Report.

" The following day the wind hauled to the southward and lasted till the 19th. During this period the young ice was broken, its edges squeezed up like hummocks, and one floe overrun by another, till it all assumed the appearance of heavy ice."

Again—" Sept. 22nd was an uncomfortable day, wind north-east, with heavy snow, the floes began to be pressed together with so much force that their edge was thrown up in immense ridges of rugged hummocks."

M'Clintock, speaking of the *Fox's* detention in Melville Bay,* says, on Oct. 3rd, " Up to Sept. 17th south-east wind prevailed, forcing the ice into a compact mass and urging it north-westward. Subsequently north-west winds set in, drifting it south, and separating the floe pieces; but the change of wind being accompanied by a considerable fall of temperature, they were either quickly cemented together again, or young ice formed over the newly opened lanes of water almost as rapidly as the surface of the sea became exposed."

Again, on Nov. 30th, he says—" For the last two months we have drifted freely backwards and forwards before north-west and south-east winds; each time we have gained a more off-shore position, being gradually separated further from the shore by fresh growths of ice, which invariably follow up every ice movement. *In this manner we have been thrust out* 80 *miles to the south-west from the nearest land, and into the free space which in autumn was open water.*"

These two paragraphs again refute the necessity of Maury's tongue of ice † thrust out of the Polar basin being necessary to account for the drifts of *Fox* and *Advance*.‡ On October 18th the young "ice three weeks old was 2 feet thick," and on November 29th " crushed up pieces of ice 4 feet thick ;" and I think the extracts I have given justify my opinion, that floes are formed all over the known Arctic regions after the middle of September, either by heavy falls of snow falling on sea-water at its freezing temperature, which form at first a thick ice-creamy substance, congealing into a solid mass as the temperature falls. Or by the sea itself freezing—gales of wind and other causes breaking this ice up, and piling floe over floe, till, as

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* Voyage of the *Fox*. † Maury, par. 477. ‡ Voyage of the *Fox*.

De Haven says, "it all assumes the appearance of heavy ice," and he might have added, the reality. The creeks, lanes, or openings thus made are again frozen over, again broken up, and so the process goes on through the long winter, in large spaces like Baffin's Bay, which is not solidly frozen over, but is always in motion. It is also to be remembered that by November this ice is 4 feet thick, and before the temperature has fallen very low—certainly not near as low a temperature as meteorologists assign to the unknown Arctic Ocean in winter, and where I see no reason for doubting that floes are being formed in a similar manner.

I now come to the drifts of the vessels.

The *Advance* was beset September 13th off Barlow Inlet, and drifted up Wellington Channel till the 22nd, when she was off Point Manning; from then till October 4th drifted but little, the winds being light and variable. De Haven * says—" All through October and November drifted to and fro by changing winds, but never passing out of Wellington Channel; for the last week of November was stationary 5 miles south-west of Beechy Island." On the 30th November, a strong breeze from the west started them down Lancaster Sound, and except that on December 7th and 8th a heavy easterly gale set them 3 miles to the westward, their drift was towards Baffin's Bay, which they entered January 1st.

The *Fox*, as I have already stated, drifted to and fro before changing winds till November 30th; was nearly stationary till December 7th, when she started on her voyage to the south, and, as M'Clintock observes, March 1st—" Except heavy south-east gales have drifted us backwards three times, have advanced 100 miles down Davis Straits." The remainder of her drift was to the southward.

I gather from these drifts that, when the *Advance* was first beset, she drifted up Wellington Channel to Point Manning; her drift was then up and down the channel before changing winds, but gradually making southing. It is evident there was at first open water near Baillie Hamilton Island, then ice began to attach itself to the land, and was gradually added to till the narrow northern exit was blocked up, while the wide outlet of Lancaster Sound was still open. This fast ice gradually extended and formed the thin end of the wedge which by degrees pushed the drifting pack to the eastward. The heavy easterly gale of two days' duration only drifting them back three miles, prove that there was no space for a retrogade movement of the pack; and as they felt no swell from the gale, it is evident there was a large body of ice to the eastward of them, and which must have been formed in a similar manner to that in which they were drifting, and did not come from the Polar basin, and that the fast ice thus gains is proved by Lancaster Sound being solidly frozen over every year.*

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* *Advance*, De Haven's Report.

The drift of the *Fox* was owing to similar causes; she drifted north till the fast-ice at the head of Baffin's Bay had formed, leaving no room in that direction when her southerly drift commenced; and as she also was well sheltered by ice from feeling the swell of southerly gales, it is evident that it was formed to the south of her, and could not have been drifted out of the Polar basin; and therefore the open sea at whose southern edge Maury imagines the middle ice of Baffin's Bay to be formed and drifted from, at present rests only upon theory unsupported by a particle of practical proof.

That Baffin's Bay is not, as Maury appears to imagine, one solid floe, but consists of an agglomeration of floes and fields of ice kept from permanent union by gales of wind and tidal causes, is proved by the lanes and openings seen by M'Clintock and De Haven during their winter drifts. It is a curious fact that, even 200′ from land, M'Clintock speaks with surprise of the greater movements of the ice at spring tides.

Reasoning from analogy, I infer that the Polar basin, which is of much larger extent than Baffin's Bay, must consist of similar floes always in motion where there is an outlet, and therefore I doubt the practicability of spring sledge-travelling from Spitzbergen towards the Pole, and advocate the Smith's Sound route for sledge operations; and I also believe the best prospect of a ship making progress is by keeping close to the weather shore. No Arctic voyager takes the pack if he can avoid it. The facts I have now laid before you lead me to the conclusion—

1st. That there is no practical proof of a warm under current into the Polar basin, or ameliorated climate caused by its rising to the surface.

2nd. That the migration of birds is no proof of it.

3rd. The season at which the open seas of Penny and Morton were seen only shows that local causes produce an earlier disruption of the ice there than elsewhere.

4th. That the drifts of the *Advance*, *Fox*, and *Resolute*, were quite unconnected with any movements of the ice in the Polar basin, and owing entirely to local causes.

The PRESIDENT, in thanking Captain Hamilton for his interesting communication, observed that this Paper contained a valuable collection of facts, brought to bear with closeness of reasoning in support of the views he adopted.

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* Reports of Esquimaux to Inglefield and M'Clintock; also crossed by Ross's and Pullen's travelling parties.

Admiral Sir **EDWARD BELCHER** said the expedition in which Captain Hamilton was engaged under his command was in the narrow channel leading to Melville Island. In looking at the immense expanse of unknown sea on the map, one would naturally say there must be a belt of water there, and wherever a tide flowed there must be a vacancy for the tide to flow to. Beginning with Behring's Straits, which he explored in 1826 and in 1827, Admiral Smyth, who was sitting beside him, would tell them that he never saw an iceberg passing south. Admiral Kellett would tell them the same; nor had any man ever seen an iceberg passing down to the southward. But, pushing farther north the next year, he was nine days under the lee of the icebergs aground in 20 fathoms.* With regard to the formation of floe-ice, he had made experiments which satisfied him that the floe-ice never formed at a greater ratio than half an inch a day, and it never attained a greater thickness than seven or eight feet. In the expedition to Melville Island, which surveyed up to where Captain Hamilton met Captain Richards, the whole of that, as far as was known, was open sea. The first year, when they passed up the Victoria Channel, they stopped to build a cairn at the end of Penny's Channel, and while they were detained there the ice came in and jammed them, and thus prevented the vessels going any further. But they took to the boats and passed the ice, and there the sea was open, the ice moving by tide east and west. Next year he travelled over the same ground, and although the temperature had been 62½° below zero, there were air-holes in the ice which had never been solidly frozen over during the winter. He broke into one of them, and the current was running so fast that if he had not put his arms over the theodolite legs he would have been carried under the ice. All the soundings he attempted to take at the seal-holes showed a strong current running to the westward. However, the next year, when they reached the farthest limit east on the 20th of May, the sea was perfectly open to the north, small ice flowing east and west as the tide changed, where any vessel might have navigated with ease. He was perfectly satisfied that if they had not been caught the first year by the ice they would have found their way out somewhere about Behring's Straits. Until they knew positively that there was land to the north of the lines they had surveyed, he was firmly of opinion that there was a large Arctic ocean in motion to the northward. With respect to going up by Smith Sound, if we wanted to determine how far the land trended on that line, that was the only place where it could be done by continuous land travelling; but he believed that after we got to the northward of 80° we should find that the land terminated, and that the sea travelled in a circle there, performing the same sort of gyration which was seen in the Sea of Sargasso.

Mr. **FINDLAY** said, with regard to the last point, namely, warm water circulating round the Arctic basin, it was well known that the water circulated to the northward along the coast of Norway; but he did not see how, with our present knowledge, the Gulf Stream could get its water into the Arctic basin. But then there was this curious fact,—how was it that the water, which was running under the same physical conditions of the rotation of the earth, should run upwards to the Pole on the eastern side of the basin and then down on the western side? It was the case that the cold water actually ran down inside the Gulf Stream right into the Gulf of Mexico. Why it ran in that way was a problem yet to be solved.

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* This was determined first by soundings, next by repeated patent-log distances between it and Icy Cape. For nine days, under strong gales, it remained at 70° 40′ N. to 70° 37′ N., Icy Cape being well fixed in 70° 19′ N. The 3-fathom bars off Icy Cape would arrest any ice I saw. On the 26th August (by my official letter) I recorded—"Lat. at noon 70° 37′; bore up E.S.E., and stood along the edge of the ice. At 4 P.M. passed the last *berg*." Also, "Bergs large and scattered."

Captain SHERARD OSBORN thought we ought to be very lenient with the Americans upon the question of Polynias, because he remembered the time when the English had Polynias of their own, and when we had recourse to one, in order to keep alive the search for Franklin. When the expedition under the late Admiral Austen came back in 1850, they proclaimed that there was an impenetrable barrier, and that it was useless to pursue the search. Happily, there was a Polar basin discovered by Captain Penny, of Aberdeen, up Wellington Channel. It was with no *arrière pensée* that he adopted that theory. He believed as honestly then that there was a Polar basin accessible in that direction as Maury believed at this moment that Smith Sound was the entrance to his Polar basin. The expedition under the command of Sir Edward Belcher, in which he took part, put an end to that hypothesis. Since then, within the last four or five years, learned Germans had conceived that the Polar basin was to be reached by pushing beyond Spitzbergen; and he was bound to say that nothing could equal the energy and the ability with which Swedes and Germans had gone to work, though it was to the honour of those who sailed in former days, that, in spite of all modern appliances, no one as yet had touched the golden spot that Captain Parry reached in 1828. So far, then, their theory of a Polar basin had broken down. To come back to Smith Sound, he agreed with Captain Hamilton that here was a region which promised the richest harvest to the geographer and the ethnologist, and where the greatest discoveries were in store for those whose fortune it might be to be sent there. Look at the Esquimaux, for instance; they were a people cut off from all human associations, living almost in a primitive state, using the weapons, tools, and appliances, of the earliest stages of the glacial period. When we dropped theorising and were prepared to take up the question of Arctic discovery quietly and earnestly, he was convinced that we should give up the search for a Polar basin as valueless, but should find much that was important and valuable to the geographers and men of science of Great Britain.

Captain HAMILTON said he never heard of real icebergs in Behring Straits, for there were no glaciers in that quarter; and with regard to Sir Edward Belcher's open sea, the portion traversed by Captain Osborn, Sir Leopold M'Clintock, Captain Richards, and himself, showed no open sea in that direction. From an elevation of three or four hundred feet nothing but ice was seen; and they might as well assume that it was an ice-bound sea to the Pole, as Sir Edward Belcher assumed it was open sea to the Pole. He agreed with Captain Sherard Osborn that the Polynia of Captain Maury was placed up Smith Sound in order to work expeditions, just as the English had formerly put a Polynia up Wellington Channel in order to work an expedition there. With regard to the formation of floe-ice, in September, 1853, in H.M.S. *Resolute*, they were in open water; a heavy north-west wind and a snow-storm came on, and at 10 o'clock at night their vessels were brought up at a freezing temperature. The snow falling into the water at the freezing temperature, formed a sludgy mass, which next day was 20 feet thick. This was the way many floes were formed; or the young ice got piled up layer after layer, and a week after the commencement of the season it had formed heavy ice. Respecting the abundance of animal life, Captain Kellett procured 320 lbs. of animal food for each man of his expedition, Captain M'Clure procured 304 lbs., Admiral Collinson, at Cambridge Bay, caught 1200 salmon at one haul, and Sir John Ross caught a great number of salmon at one haul. If animal life was a proof of a Polynia, Melville Sound was the place where it ought to be found; not up Smith Sound, where Kane was nearly starved, nor near Wellington Channel, where Sir Edward Belcher never served out a fresh meal to his ship's company.

Sir LEOPOLD M'CLINTOCK said he coincided with all the observations which Captain Hamilton had put forward in his paper; he should like to say a word as to the cause of these numerous water-spaces which were sometimes called Polynias. We never met with any of these water-spaces anywhere without also finding ample cause for them, in strong currents and tides. They were solely due to the action of tides sweeping away the ice as fast as it formed. They were common all along the coast of Greenland, and were known to the Esquimaux, who found the seals more abundant in them than elsewhere. Kane found a strong tide in Smith Sound, and it was there that his Polynia was placed, and it was there an abundance of animal life was found. Penny found strong tides in Wellington Channel, and there he also reported an "abundance of animal life." Of course, the ocean was frozen over elsewhere, and these animals sought out and congregated in large numbers wherever the sea was open, and this would account for the abundance of animal life; but it should be borne in mind that these spaces were exceedingly limited. With regard to land animals, they were more abundant in Melville Island than elsewhere, although the mean annual temperature of the island was perhaps as low as in any quarter where expeditions had wintered. He fully agreed with Captain Hamilton that nothing they had seen of late years led them to believe in the existence of a milder climate to the north. On the contrary, as far as we could see, the further we went to the north the temperature was more severe.

The PRESIDENT congratulated the Society on the admirable discussion which had taken place; a more instructive discussion he had never listened to. Their thanks were due to Captain Hamilton, and also to Sir Edward Belcher, Captain Osborn, and other Arctic officers, for the able manner in which they had marshalled interesting facts in support of their views.

ADDITIONAL NOTICES.

(Printed by order of Council.)

1. *Letter from* T. K. LYNCH, Esq., F.R.G.S., *on* Consul TAYLOR'S *Journey to the Source of the Euphrates.*

DEAR SIR,

I have just received from Mr. John George Taylor, her Majesty's Consul at Erzeroom, the following account of the country in the immediate neighbourhood of Diadeen, and as it mentions the discovery of an active volcano, and some very peculiar sulphur springs, and enters minutely into the actual state of the country at the source of the Murad Su, or Euphrates, I have deemed the subject of sufficient interest to communicate it to the Society, particularly as the above features have not been described, as far as I am aware, by any other traveller. Texier, who travelled from Van by Ala Koë and Merec, passed too far to the eastward, and Mr. Brant, who skirted the lake from Van to Akhlat, and proceeded from that place by the Sapirs Dagh and Ardjish to Bayageed, and crossed the Ala Dagh far to the westward, over, as his account states, its highest range, where he notices the several rills which,